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RESEARCH ARTICLE

New records on the distribution and habitat of the northern naked-tailed armadillo, *Cabassous centralis* (Mammalia, Cingulata, Chlamyphoridae) in Costa Rica

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Abstract

The northern naked-tailed armadillo, *Cabassous centralis*, is a rare and elusive species. It ranges from southern Mexico to northern South America. It has been detected in several types of habitats, but appears to prefer Tropical and Subtropical broadleaf forests. In Costa Rica, this species is difficult to observe and there are only eight records reported in the scientific literature. To search records of this armadillo, we used camera traps in north-western Costa Rica and visited several additional localities in the centre and the Caribbean lowlands of the country. We also examined and assessed records of this species from the Global Biodiversity Information Facility (GBIF) database. We added four new locality records for *C. centralis* in Costa Rica, based on photos from camera traps and field observations. We found only three localities (five records) in GBIF additional to the eight reported in literature. Habitat in these new Costa Rican localities reported here varied from mature dense forest (one site) to semi-urban areas (two sites). Additionally, two individuals were detected in secondary forest patches, one of them adjacent to mature riparian forest. Given the species' scarcity, much additional information still is required to ground protection actions in a scientific framework.

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PENSOFT.

Keywords
Biological reserve, *Dasypus*, secondary forest, semi-urban area, timber plantation

Introduction

The northern naked-tailed armadillo, *Cabassous centralis* (G. S. Miller, 1899) (Mammalia: Cingulata: Chlamyphoridae), is a widespread species ranging from southern Mexico, through Central America to western Colombia, north-western Ecuador and north-western Venezuela (Gardner 2005; Tirira 2007; Hayssen et al. 2013; Feijó and Anacleto 2021). It is considered rare (Superina and Abba 2018) due to the low number of known records in comparison to other xenarthrans (species in the orders Cingulata and Pilosa). Marques Santos et al. (2019) ranked it 22nd out of 31 xenarthran species in terms of available records and the species remains poorly known (Reid 2009; Feijó and Anacleto 2021). The current status of the world populations of *C. centralis* is unknown and, as such, the species is listed by the IUCN as Data Deficient (Tirira et al. 2014). This classification is owed to the limited knowledge about this species and lack of available information on the impacts of habitat loss, as well as other threats (Tirira et al. 2014). Moreover, it is extensively hypothesised that habitat destruction is advancing at alarming rates in Central and South America (Global Forest Watch 2021).

Cabassous centralis is found in an elevational range from sea level to 3018 m (Díaz-N. and Sánchez Giraldo 2008). This armadillo lives in humid forests, dry and open habitats, savannahs and grasslands, secondary and mixed forests, agricultural areas and at forest edges in rocky terrain (Mora 2000). However, recent data (Feijó and Anacleto 2021) suggested that, despite the existence of some isolated records in open patches, *C. centralis* is found only at forested regions in the Amazon and Central America formations. It also has been recorded in tropical moist montane forests and in the sub-paramo of the Colombian Central Cordillera (Sánchez et al. 2004; Díaz-N. and Sánchez-Giraldo 2008).

Northern naked-tailed armadillos have a head and body length of 300–378 mm and a mass of 2.0–3.5 kg (Superina and Abba 2018; Feijó and Anacleto 2021). It is a broad, flattened animal with a short, pinkish tail (Mora 2000). The carapace has 11–13 bands that allow the animal to move easily (Reid 2009). The forefeet have five large claws, the middle one is particularly prominent and sickle-shaped (Emmons and Feer 1997). *C. centralis* is solitary, except in the brief breeding season (Mora 2000), nocturnal although occasionally seen by day (Reid 2009), fossorial and spend most of their time underground in excavated tunnels (Cuarón 2005) and in holes they make in river banks or the ground (Reid 2009).

Generally, the northern naked-tailed armadillo is not hunted by humans due to its odour and local beliefs (Hayssen et al. 2013), except in some specific areas, such as in parts of the Colombian Andes (Aldana et al. 2006; Castaño and Corrales 2010). In addition, its habitat has been very reduced in certain regions, in particular the Andes and, in parts of its distribution range, people kill it because it is considered

poisonous (Hayssen et al. 2013). The common name of this species in Costa Rica is "armadillo zopilote" (vulture armadillo) on account of its pungent, musky and unpleasant smell (Reid 2009), but the name might be derived from the vulture-like grunts and gurgling squeals it emits while running away when it feels threatened.

Supposedly, the northern naked-tailed armadillo once was widely distributed throughout much of Costa Rica (Hall 1981: 282) from sea level up to 1800 m elevation, but more frequently in cloud forests above 1500 m elevation than in lowland forests (Genoways and Timm 2003). In Costa Rica, this species generally has been difficult to observe and considered rare (Mora 2000). A photograph of this armadillo was recently obtained in a camera trap at an altered site in San Ramón de Alajuela (Sánchez-Brenes and Monge 2019). These authors pointed out that the northern naked-tailed armadillo currently is observed in altered habitats because it is threatened by several anthropogenic factors, including land use changes and hunting. Here, we report new sightings and new localities of this species from Costa Rica, obtained by camera traps and direct observations, both in disturbed and pristine habitats.

Methods

We carried out a wildlife census at two sites in Sierra Zapote Reserve – SZR (10°19'0.4"N, 84°59'21"W y 10°18'58"N, 84°59'8.9"W), Abangares Municipality, Guanacaste Province in north-western Costa Rica. We also undertook occasional wildlife surveys including search for armadillos at La Catarata Reserve (LCR; 10°11' 50"N, 84°34'19"W), San Ramón, Alajuela Province, central Costa Rica. In addition, we gathered information as to presence of the species from two other sites in the country: i.) La Paz, also in San Ramón (10°08'54"N, 84°31'52"W), and ii.) Guápiles, Limón Province in the Caribbean lowlands (10°12'48"N, 83°52'23"W). The SZR covers over 70 ha of secondary and primary forest and patches of forest in the process of regeneration. Contiguous to the Reserve, there is an agricultural landscape of pastures and fragments of secondary forest. This protected area was used for cattle ranching operations until 1985, when the operators of the property planted teak (*Tectona Grandis* Linn. F), beechwood (*Gmelina arborea* Roxb.) and pochote (*Pachira quinata* (Jacq.) W.S.Alverson) for timber production. However, by the year 2000, the property was turned over to nature protection, terminating forestry operations. Subsequently, the owners implemented a regime of natural and assisted regeneration. As a result, much of the original forest composition has been recovered. La Catarata Reserve (LCR) is a private landholding of 119 ha established as a Biological Reserve since 1998. LCR is surrounded by several farms under a forest protection programme (Payment for Environmental Services). LCR and surrounding farms all together form a block of forest of ca. 1000 ha adjacent to the 7800 ha Alberto Manuel Brenes Biological Reserve.

In SZR, we placed five cameras (2 Bushnell, 2 Browning and 1 Alpha) in strategic sites where we previously had found evidence of mammals, including tracks, faeces, hair or trails. Cameras were placed between 100 and 400 m apart and were active 24 hours a day and set with an interval of 0.3 seconds between each shot. We

used Calvin Klein Obsession (CKO) as bait to attract individuals and obtain more and better pictures to facilitate species identification. CKO has been shown to elicit a response in felids (Noss et al. 2013; Mills et al. 2019). The sampling effort reported herein was 291 trap-nights from May 2020 to May 2021. One trap night is equivalent to one camera trap station working continuously for 24 h.

We visited LCR at least once a month during 2019 and 2020 to undertake wildlife observations primarily for the purposes of completing a bird list for birdwatchers. These visits included night walks and occasional bat mist netting. We also undertook informal interviews with hunters and rural people in at least 10 sites in the country regarding wildlife sightings. We carried out occasional wildlife surveys taking advantage of guiding tours in the Caribbean side of the country, mainly at Guápiles, Pococí County in Limón Province (10°08'54"N, 83°31'52"W).

To document records of the presence of the northern naked-tailed armadillo in Costa Rica, we searched for published reports of this species in the country. We also reviewed records of *Cabassous centralis* in the Global Biodiversity Information Facility (GBIF 2021).

Results

We recorded four new localities for *Cabassous centralis* in Costa Rica (Table 1, Fig. 1), one from camera traps and three from direct sightings. At RSZ, we obtained four photographs of this armadillo in 291 trap-nights. The first photograph was obtained on 08 August 2020 at 00:49 h in a secondary forest adjacent to mature riparian forest at 304 m elevation (Table 1). The second photo was taken on 23 February 2021 at 04:39 h in the same site 1 (Table 1). We were unable to ascertain whether it was the same individual as in the first photo. The third photograph was taken at 364 m straight line distance from site 1 (site 2), also in a secondary forest on 21 December 2020 at 23:35 h (Table 1). The fourth photograph was obtained on

Table 1. Records of the northern naked-tailed armadillo detected at four localities (L): two sites (S) at Sierra Zapote Reserve, Guanacaste (locality 1), one site at La Catarata Reserve, Alajuela, (locality 2), one site at Guápiles, Caribbean lowlands (locality 3) and one site at San Ramón (locality 4). Costa Rica. SF = secondary forest; SG = small gap in dense forest; SUA= semi-urban areas. Methods of detection: CT = camera trap, DO = direct observation.

L/S	Coordinates	Elevation (m)	Habitat	Date	Time	Method
1/1	10°19'0.4"N, 84°59'21"W	352	SF	21 December 2020	23:35 h	CT
1/1	10°19'0.4"N, 84°59'21"W	352	SF	16 January 2021	21:15 h	CT
1/2	10°18'58"N, 84°59'8.9"W	304	SF	08 August 2020	00:49 h	CT
1/2	10°18'58"N, 84°59'8.9"W	304	SF	23 February 2021	04:39 h	CT
2/1	10°11'50"N, 84°34'19"W	1241	SG	10 October 2016	08:10 h	DO
2/1	10°11'50"N, 84°34'19"W	1241	SG	15 November 2017	10:41 h	DO
2/1	10°11'50"N, 84°34'19"W	1241	SG	10 November 2018	13:35 h	DO
2/1	10°11'50"N, 84°34'19"W	1241	SG	16 October 2019	08:14 h	DO
3/1	10°12'48"N, 83°52'23"W	208	SUA	31 July 2020	15:45 h	DO
4/1	10°08'54"N, 84°31'52"W	1094	SUA	22 January 2021	12:15 h	DO

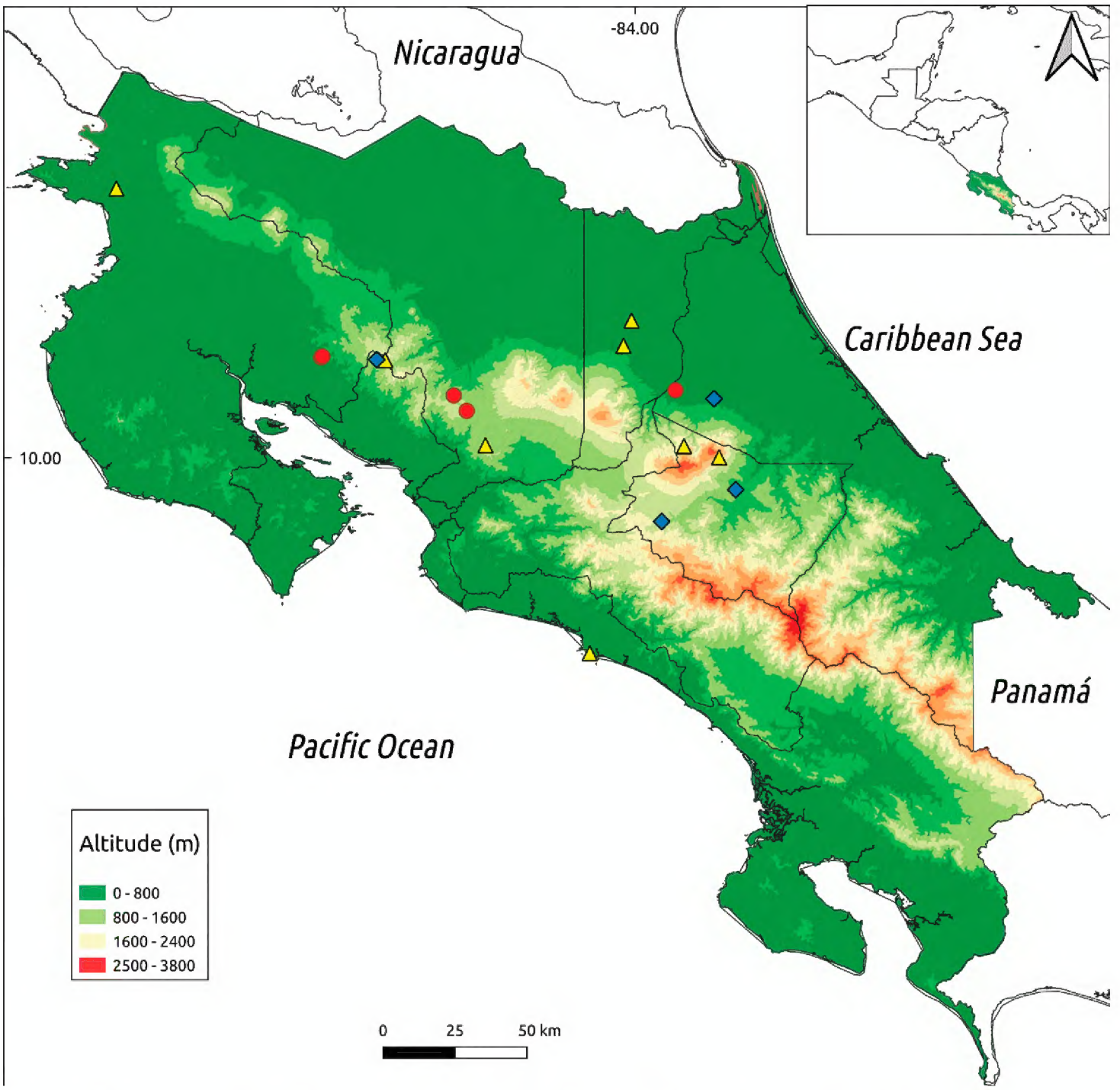

Figure 1. Distribution of the northern naked-tailed armadillo (*Cabassous centralis*). Yellow triangles correspond to localities reported in literature; blue diamonds represent localities obtained from the Global Biodiversity Information Facility database; red circles indicate the four new localities reported in this study.

16 January 2021 also at site 2 (Table 1); as with site 1, we were unable to ascertain whether it was the same individual as in the first photo in site 2. Other species of mammals documented at RSZ (Table 2) included the nine-banded armadillo (*Dasypus novemcinctus*, 53 photographs), the only other armadillo species present in this study area and in Costa Rica in general and 15 additional species (Table 2).

In addition, in October and November 2016–2019, we observed northern naked-tailed armadillos in a small garden-type clearing (16 m^2) besides the RLC shelter hut in the middle of mature dense forest. On 10 October 2016, one armadillo was active at this site starting at 08:10 h. On occasion, this individual was active at the location for periods of up to two hours. On one occasion, we filmed the

Table 2. Mammal species photographed from May 2020 to March 2021 at Sierra Zapote Reserve, Abangares, Guanacaste, Costa Rica.

Order	Family	Species	Common name
Didelphimorphia	Didelphidae	*Didelphis marsupialis*	Common Opossum
		Philander vossi	Voss Four-eyed Opossum
Cingulata	Chlamyphoridae	*Cabassous centralis*	Northern naked-tailed armadillo
	Dasypodidae	*Dasypus novemcinctus*	Nine-banded Armadillo
Pilosa	Myrmecophagidae	*Tamandua mexicana*	Northern Tamandua
Primates	Cebidae	*Cebus imitator*	Panamanian White-faced Capuchin
Carnivora	Canidae	*Canis latrans*	Coyote
	Felidae	*Leopardus pardalis*	Ocelot
		Puma concolor	Puma
	Mephitidae	*Conepatus semistriatus*	Striped Hog-nosed Skunk
		Spilogale angustifrons	Eastern Spotted Skunk
	Mustelidae	*Eira barbara*	Tayra
	Procyonidae	*Procyon lotor*	Northern Raccoon
		Nasua narica	White-nosed Coati
Artiodactyla	Tayassuidae	*Dicotyles tajacu*	Collared Peccary
Rodentia	Cuniculidae	*Cuniculus paca*	Paca
	Dasyproctidae	*Dasyprocta punctata*	Central America Agouti
	Sciuridae	*Sciurus variegatoides*	Variegated Squirrel

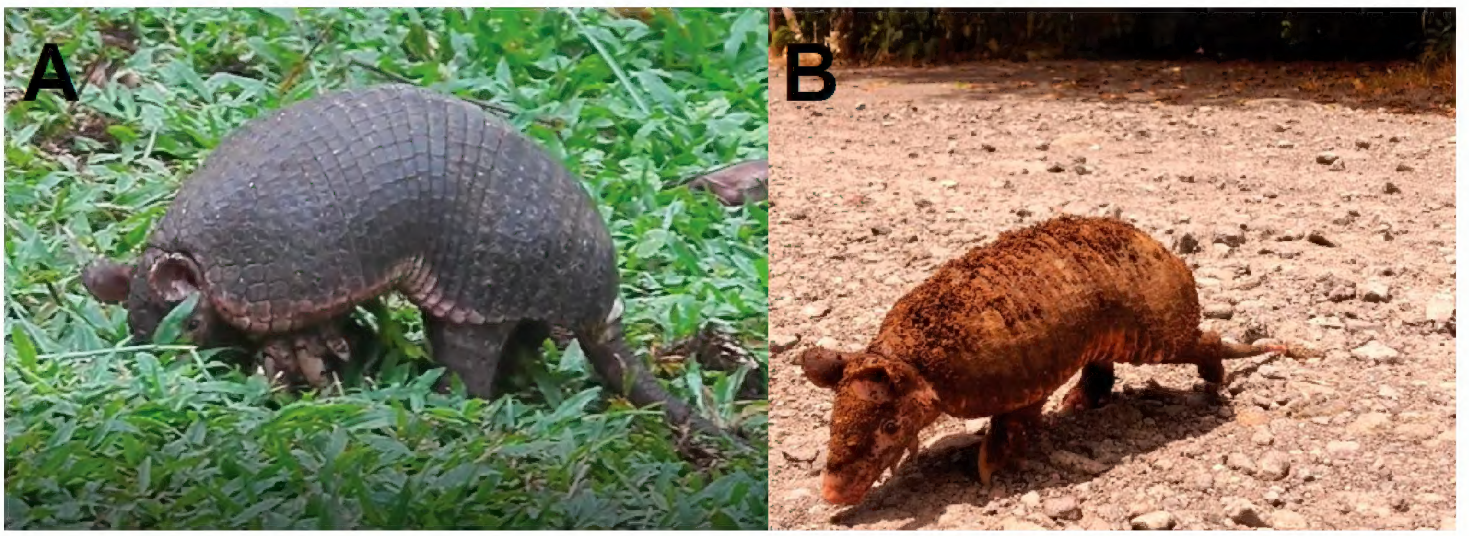

Figure 2. A) An individual of the northern naked-tailed armadillo (*Cabassous centralis*) at La Catarata Reserve, La Paz, San Ramón, Alajuela (locality 4/1, Table 1) and **B)** another individual of the same species at La Unión, Guápiles (locality 3/1, Table 1), Costa Rica.

armadillo (Fig. 2) for a few seconds, when it was active for several minutes. On 31 July 2020 at 12:02 h, we encountered a single armadillo crossing an open area at La Unión, Guápiles, in the Caribbean lowlands (10°12'48"N, 83°52'23"W; Figs 2 and 3). On 23 January 2021, a *C. centralis* was caught in a football field in the village of La Paz, San Ramón, Alajuela (10°08'54"N, 84°31'52"W; Fig. 3), but it was released into a patch of riparian forest close to the point of capture.

We found eight localities reported previously of the northern naked-tailed armadillo in Costa Rica in literature (Fig. 1). We also found five records belonging to four localities of this species in the GBIF databases (Table 3, Fig. 1). Three of these records are georeferenced and the locality of Monteverde, Puntarenas, already was included in literature (Tables 1 and 3).

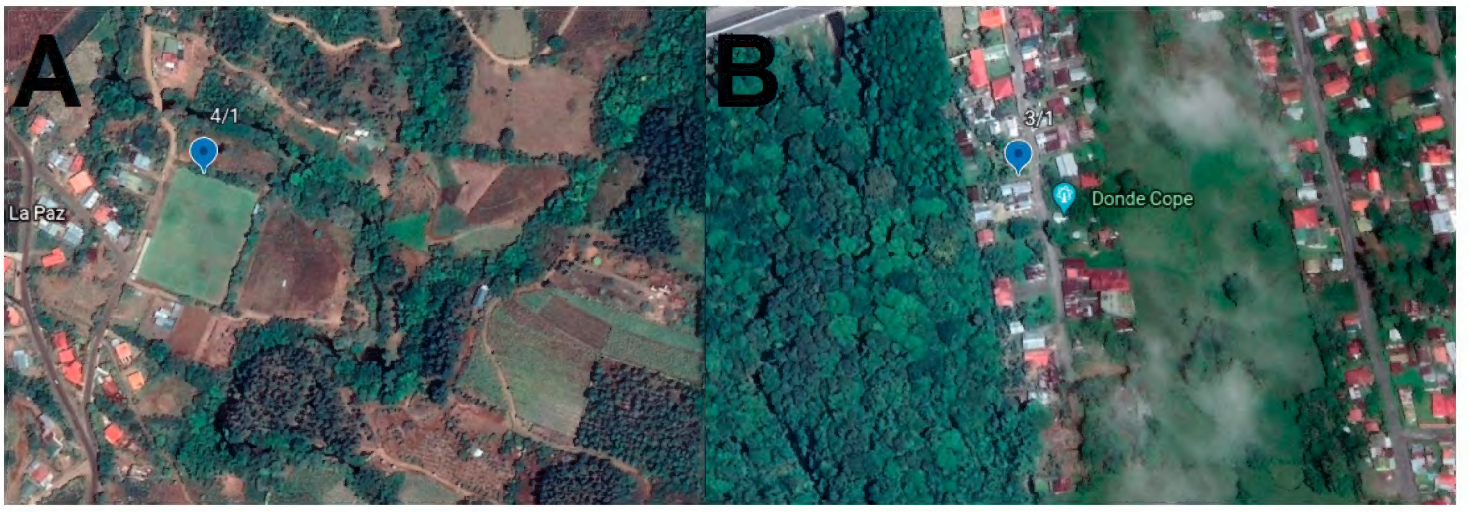

Figure 3. Two of the locality records of *Cabassous centralis* reported here: **A)** the blue mark points to the football field in La Paz, San Ramón as locality 4/1 (Table 1) and **B)** the blue mark points to the observation site in La Unión, Guápiles as locality 3/1 (Table 1); both in Costa Rica.

Table 3. Data of specimens of the northern naked-tailed armadillo (*Cabassous centralis*) from Costa Rica gathered from the Global Biodiversity Information Facility (GBIF).

Catalogue number	Sex	Year	Province	Locality	Coordinates
UMMZ 108579	m	1957	Cartago	Turrialba	9°54'00"N, 83°40'59"W
UMMZ 67548	m	1933	Cartago	Río Navarro	9°48'00"N, 83°55'00"W
KUM 157596	__	1994	Puntarenas	Monteverde	10°18'36"N, 84°48'53"W
AMNH M-12438	f	1896	Limón	Suerre, Siquirres	10°11'20"N, 83°49'12"W
AMNH -10752	f	1896	Limón	Suerre, Siquirres	10°11'20"N, 83°49'12"W

UMMZ = University of Michigan Museum of Zoology, Mammal Collection;
KUM = University of Kansas Biodiversity Institute, Mammalogy Collection;
AMNH = American Museum of Natural History, Mammal Collections.

Discussion

We found and report four new localities of *C. centralis* in Costa Rica, in addition to the eight localities previously registered for the country and four additional localities extracted from the GBIF database (Fig. 1). Additionally, this species has been photographed seven times or 9.2% of 76 studies with camera traps placed on the forest understorey throughout Costa Rica (Artavia 2015). Although Artavia (2015) pointed out three more records of this species (a total of 10), unfortunately the author failed to provide more information, such as coordinates or exact localities, so these are not included in Fig. 1. Our four photographic captures, therefore, are amongst the few of this kind that are accompanied with locality data. In a study covering 7380 trap-nights, a single detection of *C. centralis* was recorded in Chiapas, Mexico (Juárez-López et al. 2017), a relative success rate for that species of 0.014%. Similarly, Soriero et al. (2018) obtained three photographs (likely of different individuals) over 4003 trap-nights in Belize (0.075%). Both studies recorded frequent photographic occurrences of *D. novemcinctus*. Our relative success for *D. novemcinctus* was 18.2%: 243 times higher relative success than in Belize and 1344 times that of southern Mexico.

The four new localities reported here for *C. centralis* are within the theoretical range of the species in Costa Rica (Hall 1981: 282). Nevertheless, the records

are relevant, first due to this species being rare to observe, thus any sighting of it is valuable because it provides information about its ecology, particularly as to the types of habitats that the species uses in Costa Rica. However, the fact that we observed individuals in these sites does not mean these are preferred habitats. Second, two of the four localities reported here are semi-urban areas with some remnant vegetation in the immediate vicinity and one area is under restoration at LSZ. The original forest of LSZ was cut down, then used for timber extraction and then left to undergo natural regeneration. We interpret the record in light of this sequence of events as indicative that, with the return of original vegetation, there also has been some restoration of fauna, including rare species, such as the northern naked-tailed armadillo. Third, there have been few previous sightings of *C. centralis* in the country, including a recent one in a disturbed area in San Ramón (Sánchez and Monge 2019). Here, we report it from four additional sites; however, northern naked-tailed armadillos are not commonly seen or captured, which may be due to its secretive habits and it appears to be particularly elusive (Superina and Abba 2018). The observations of *C. centralis* from semi-urban areas (Table 1) may indicate that some animals are either becoming more habituated to human settlements or these may just be random events.

Although *C. centralis* apparently tolerate some degree of habitat degradation, they seem to prefer mature, well-preserved forests (Tirira et al. 2014; Feijó and Anacleto 2021). As a result, severe habitat transformation and degradation are likely to have a negative impact on the species (Tirira et al. 2014). Global Forest Watch data indicate that Costa Rica has lost 11% of its total tree cover from 2002 to 2020; similar data for Nicaragua, Panama and Colombia, are 33%, 19% and 38%, respectively. In addition, there are other threats to this species throughout its distribution, such as road-kills and hunting (Aldana et al. 2006; Delgado-V. 2007; Castaño and Corrales 2010). *Cabassous centralis* represented 2% of the road-kills of vertebrates in Colombia (Delgado-V. 2007) where it sometimes is used as food in some regions in the northern Andes (Aldana et al. 2006; Castaño and Corrales 2010). The population trend of *C. centralis* currently is unknown (Tirira et al. 2014), and the response of the species to habitat loss is not clear because there is not enough available information (Tirira et al. 2014).

Conclusions

The new localities records reported herein increased to 15 the number of confirmed localities for the northern naked-tailed armadillo in Costa Rica and add new information on the type of habitats this armadillo can use (this number does not include the records reported by Artavia 2015, see Discussion). Three of our four records come from open or disturbed areas. However, all these sites are close to major forest remnants or patches connected to more pristine habitats that may contain suitable areas for *C. centralis* populations (Fig. 3). The lack of information about the habitat requirements of *C. centralis*, as well as its daily activity patterns and its interaction

with other species, all are factors hampering effective strategies to conserve it. It is urgent to determine the population status of the species throughout its range, as well as the impact of real and potential threats and habitat preferences. Despite the existence of some peripheral records in isolated open patches, *C. centralis* is confined to forested regions in the Amazon and Central America formations.

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